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ON THE BEHAVIOUR OF THE IONOSPHERE DURING SUDDEN IONOSPHERIC DISTURBANCES.

The ionization equation was solved for the electron production function linear with time. It is indicated that the development of a flare in H_α light is not representative for an active radiation of flare. The method of determination of the value $\tau_0 = \frac{1}{\alpha N_0}$ and of the coruse with time of solar flare radiation active for the ionosphere is suggested.

I.

Relative electron density variations during sudden ionospheric disturbances (SID'S) due to active emission of solar flares are described by the well-known equation:

$$\tau_0 = \frac{d}{dt} \frac{N(t)}{N_0} = \frac{I(t)}{I_0} - \left(\frac{N(t)}{N_0}\right) \tag{1}$$

Here N_0 is electron density and I_0 - function of the electron production (both - at the moment of SIO beginning).

Recently a solution of equation (1) has been found /1,2/ for $I(t)/I_0$ in the form of a rectangular pulse. If is a linear function of time, i.e. $I(t)/I_0 = P_0 + \frac{t}{T}$

$$\frac{N(t)}{N_0} = \frac{1}{\beta^{1/3}} \cdot \frac{[v^{10} - a\beta^{1/3} \cdot v^0]U - [U^{10} - a\beta^{1/3}U^0]\, v'}{[v^{10} - a\beta^{1/3} \cdot v^0]U - [U^{10} - a\beta^{1/3}U^0]\, v} \tag{2}$$

where $\beta = \frac{T}{\tau_0}$; T is a parameter characterizind the variations of $I(t)/I_0$; the values of $T > 0$ correspond to an increasing $I(t)/I_0$ and $T < 0$ - to a decreasing one $a = \frac{N(0)}{N_0}$ for intervals having different values of T; u, v, u', v' are the Airy functions and their derivatives with argument $Z = \beta^{2/3}(P_0 + \frac{t}{T})$ and u^0, v^0, u^{10}, v^{10} are the same ones with argument $Z^0 = \beta^{2/3} P_0$

Lets us consider some applications of those relations.

It seems interesting to find out if the debelopment of a flare in H_α light is peprosentative for an active flare emission /4,5/. The development curves of flares (the course with time of intensity and emission flow in H_α light) were approximated by the broken lines.

Electron density variations were computed by means of equation (2) assuming that time variations of active emission are the same as in H_α light, but with a greater amplitude. These calculations were made for flares 31/VIII-56, 28/VIII-57, 3/IX-57 and 23/XI-57. On the other hand, electron density variations were determined by known measured values of f min /6/ to compare them with observations. Fig.1 gives an example of comparison of observed values of N(t) No with those computed by a described method. Graphs of fig. 1 shows that the development of the flare in H_α light is not representative for the active emission. Apparently this emission is X-ray radiation of the flare. The reverse problem is also of a great interest. The ionospheric parameter τ_o and the course with time of active emission can be determined if there are continuous measurements of N(t)/No during SID (for D- region by measurements of absorption, f min e.t;c.) Really, supposing that an active emission in initial stage of development of the flare can be approsimated by triangular pulse we can find τ_o and parameters determining that triangle, they are: tm - time delay of electron density masimum Nm/No relatively to the top of the triangle; To and T_1 - values of T for different sides of triangle; to - the total time of I(t)/Io growth. To solve this problem it is necessary to have five equations:

$$\frac{Nm}{No} = \psi\,(To_1 to_1 T_1 tm_1 \tau_o) \qquad (3a)$$

$$\frac{Nm}{No} = \sqrt{1 + \frac{to}{To} + \frac{tm}{T_1}} \qquad (3b)$$

$$\theta = t_o + tm \qquad (3c)$$

$$\frac{d^2}{dt^2}\left(\frac{N}{No}\right)\Bigg|_{t=o} = \frac{1}{\tau_0 \, To} \qquad (3d)$$

$$\frac{d^2}{dt^2}\left(\frac{N}{No}\right)_{t=tm} = \frac{1}{\tau_o \, T_1} \qquad (3e)$$

where To 0 and $T_1 \neq 0$. The equation (3a) is an equation (2) for the moment tm. The relation (3b) is find from the condition $\frac{d}{dt}\left(\frac{N}{No}\right)_{t=tm} = 0$. . . In (3c) θ is the time, measured from the beginning of SID to the moment of $\frac{N(t)}{No}$ maximum. The equations (3d) and (3d) and (3e) for the moments t=0 and t=tm respectively are obtained by calculations of the second derivatives of N(t)/No; their meanings must be taken from experimental graph N(t)/No. The value τ_o can be found from solution of equations (3); the course with time I(t)Io can be determined by this method of calculation it must be noted that the course with time of N(t)/No during SID must be continuous and sufficiently smooth.

The course with time of $I(t)/I_o$ for the flare 28/VIII-57, is presented on fig.2 calculated by just described method. Variations of N(t)/No during SID were determined by fmin; the smoothed values of fmin were used. It was found, that

τ = 4800 sec. and t_m = 600 sec.

Thus, taking into account the nonstationary process during SID [1/s] the method of determination fo value $\tau_o = \frac{1}{\alpha No}$ and course with time of solar flares emission, active for ionosphere is suggested.

It seems possible to apply this method to the determination of an effective recombination coefficient using the dirunal changes of critical frequencies for different ionospheric layers.

It would be also very interesting to compare such analysis of SID with the data on X-ray radiation of flares, obtained on the artificial satellites of the Earth.

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CAPTIONS.

Fig. 1 Comparison of the experimental and theoretical curbes of the electron density variations during the flares.

Time - Moscow; τ_1 = 4000 sec.

a) 1. Intensity variations $I(t)/I_o$ of the flare in H

2. Variations $\frac{N(t)}{No}$ exp determined by fmin

3. Theoretical variations $\frac{N(t)}{No} / th$

b,c) 1. Variations of the emission flow. $\Phi(t) / \Phi_o$ of the flare in H_α

2. Variations $\frac{N(t)}{No} / exp$ determined by f_{min}.

3. Theoretical variations $\frac{N(t)}{No} / th$.

Fig.2 Variations of electron production function $I(t)/Io$ during the flare 28/VIII-57

1. Variations $\frac{N(t)}{No} /$ exp- determined by f min

22 Smoothed curve $\frac{N(t)}{No} /$ exp.

3. Approximating triangular function $\frac{I(t)}{Io}$.

4. Variations $I(t) / I_o$ computed by eq. (1) with τ_o = 4800 sec.